Motion Drive System Interface Control Document

This document defines the minimum requirements for the interface between the instrument control computer and the monochromator control computer of a system that incorporates a Double Focussing Monochromator. This document is subject to the top-level-specification for the Double Focussing Monochromator. The document shall become effective only if all owners whose names appear below have signed it. Changes to the signed document shall only be initiated by one of the owners, or their replacements, at which time a new document including the proposed revision shall be prepared. Changes shall become effective only after all parties shall have signed the new document. The old document shall remain part of the record.

0 Control Data

0.1. Project Name
Doubly Focusing Monochromator

0.2. Revision (-, A, B ….. AA, BB, …. *etc*.)
Revision – (DRAFT)

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1. Definitions

1.1. Instrument Control System (ICS)
An ensemble of software, computers and other electronic devices that allow the neutron spectrometer to execute its function. Some of these elements are further defined below. The ICS is NIST's responsibility.

1.2. Instrument Control Computer (ICC)
Computer that drives the experiment. This device shall be the main instrument user interface and takes care of all data acquisition, filing, and time sensitive issues such as counting. The ICC shall communicate values in physical units to other computers that are part of the ICS. The ICC is NIST's responsibility.

1.3. Monochromator Control Computer (MCC).
This device shall be subject to the control of the ICC. It receives commands from and reports back status to the ICC. It also contains a limited user interface such as slewing and jogging of individual axes. It shall be capable of interpreting high level commands. For example when issued an energy value, it shall be capable of calculating the corresponding positions of all motors operated through it.

1.4. Motor driver (MD)
A device that is driven by the MCC which handles a specific motion axis.

1.5. Motor (M)
A device that presumably acts on pulses created by an MD.

1.6. Encoder (E)
A device attached to a Motor that independently monitors a motor's progress.

1.7. Limit switch (LS)
A switching device that aborts motor motion. Typically a motion is equipped with two limit switches: one at each end of a drive interval.

1.8. Home switch (HS)
A switching device that allows an axis to be returned to a known position. When it is impractical to build in a home switch, it can be made to coincide with a limit switch.

2. Interface control specification

2.1. The electrical interface between the MCC and ICC shall be according to RS232-C. Typical baud rate shall be 2400 to 9600.

2.2. The communication between MCC and ICC shall be ASCII. Headers and trailers identifying input as well as control-digits (check-sum) shall be added and shall be specified in a manual.

2.3. The MCC shall at all times be expecting an "abort" command and upon receipt of such shall stop all drive action, while at the same time maintaining control and knowledge of the axis positions.

2.4. At a minimum, at all times the MCC shall be able to receive (and act on) the following input. Replies as specified below are immediate as a way of handshaking and in all instances except the "status request" and the "report motor value" they shall be the repetition of the command itself.

2.4.1. Command:
Drive specific motion to HS and reset its "hard" value (this drive shall take place in a controlled way, such that it can always be reproduced, see also paragraph 3.6). Maintain previously determined offset between actual physical position (soft position) and hard position.
Reply:
Drive specific motion to HS.

2.4.2. Command:
At any position, initialize a motion to a specific value, thus changing the value of its "soft" position. This command alters the offset between soft and hard position.
Reply:
Initialize motion to specific value.

2.4.3. Command:
Drive motor(s) to specified "hard" position(s).
Reply:
Drive motor(s) to "hard" positions.

2.4.4. Command:
Drive motor(s) to specified "soft" position(s).
Reply:
Drive motor(s) to "soft" position(s)

2.4.5. Command:
Set scattering angle 2*q*.
Reply:
Set scattering angle 2*q*.

2.4.6. Command:
Set angle between frame and incident beam.
Reply:
Set angle between frame and incident beam.

2.4.7. Command:
Define monochromator *d*-spacing. Units shall be in Angstrom.
Reply:
Define monochromator *d*-spacing.

2.4.8. Command:

Set for incident energy E, and set system for monochromatic double focusing at that energy. Units shall be in meV. The scattering angle ($2q$) for given E and d is then given by

$$2q = 2\arcsin\left(\frac{4.52182}{d\sqrt{E(meV)}}\right)$$

Reply:

Set for incident energy E.

2.4.9. Command:

Set MCU columns to specular reflection of a beam from the center of the source to the center of the sample.

Reply:

Set MCU columns to specular reflection.

2.4.10. Command:

Abort command (see 2.3).

Reply:

Abort received

2.4.11. Command:

Status request.

Reply:

Any of the following:

2.4.11.1. Motor(s) running

2.4.11.2 Motors idle

2.4.11.3. Error from (any) motor drive, error code shall be passed along for ICC interpretation. This error shall cover situations like limit switch violation, stall detected, etc.

2.4.12. *Command:*

Report motor value(s)

Reply:

Motor value(s)

Additional mathematical relationships associated with 2.4.7, 2.4.8 and 2.4.9 will be provided by Collin Broholm.

2.5 The communication between ICC and MCC shall be synchronous, which on the ICC end will be dealt with by interpreting the replies to the commands outlined in paragraph 2.4.

A typical move command sequence will be handled in the following way:

ICC issues move command to move one or more motors.
MCC replies with the command string.
ICC starts polling status in "do while" loop until "motors idle" is returned
ICC asks for motor value(s).
Done

2.6. Timing issues

2.6.1. It shall be possible to halt the device with a command from the main computer in no more that 1 second.

2.6.2. Setting of the device to a specific energy shall take less than 5 sec if going from one energy to another, when those energies are close to one another (efficiency during energy scan).

2.6.3. Overhead time (ICC-MCC communication and MCC response) associated with the setting of a single motor (not the actual time taken to move) should be less than 1 sec.

2.7. MCC User Interface

2.7.1. Input device shall be touch screen.

2.7.2. List showing positions (hard and soft) of all motors.

2.7.3. List showing LS status.

2.7.4. Slew and jog buttons for every motion.

2.7.5. Edit screens that allow motor parameter editing.

2.7.6. Enable/Disable LS.

2.7.7. Enable/Disable Encoder.

2.7.8. Enable/Disable encoder driven position correction.

2.7.9. Enable/Disable stall detection (encoder based).

2.7.10. Enable/Disable position maintenance (encoder based)

These user interface elements do not all have to be accessed from the same screen. For example, the top-level screen could show motor positions and a status message. This is conveniently done in a cartoon diagram of the setup. Edit screens one level below that (for each axis) can take care of the option selections.

3. Miscellaneous Related Specifications

3.1 Monochromator Control Computer

Final specification of this device is JHU's responsibility. NIST will only specify that it shall be a rack mounted PC and an LCD Monitor.

3.2. Motor drivers

Any motor driver selection shall be in consultation with NIST to address noise issues particular to the NIST environment.

3.3. Motors

Any motor selection shall be in consultation with NIST to address noise issues particular to the NIST environment.

3.4. Encoders

Any encoder selection shall be in consultation with NIST to address noise issues particular to the NIST environment Encoders are not a requirement if top level specifications can be achieved without them.

3.5 Limit Switches

Limit switches are not a requirement if top level specifications can be achieved without them

3.6 Cabling

Cabling shall be selected in consultation with NIST so that noise issues that are particular to the NIST environment can be properly addressed.

3.7 Home Switches

Home switch recovery shall be within the tolerance that has been specified earlier.

3.8 Units of measure

Motions driving an angular range shall be governed by numbers in degrees. Motor(s) that define curvature of monochromator crystal strip assemblies shall be governed by their radius of curvature in meters.